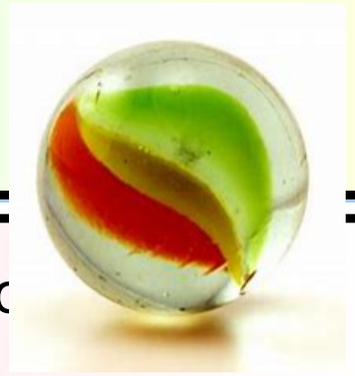
(6) M - Identify uncertainty in measurements
(7) S - Calculate percentage uncertainty
(8) C - Combine absolute and percentage uncertainty

Lesson 4. Uncertainty 2

STARTER:
Measure the diameter of the marble with a) micrometer and a b) caliper.
Write the value and the <u>percentage</u> uncertainly of



Kilo 10^3

Mega 10^6

Giga 10^9

Compare the % uncertainty of both and suggest reasc for the difference

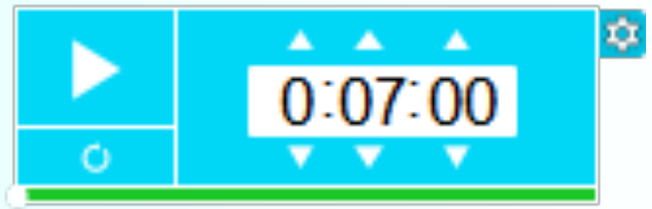
Explain the difficulties you encoutered when measuring the marble.

Key point

a) $15.525\,mm \pm 0.003\%$

b) $15.75\,mm \pm 3\%$

(6) M - Identify uncertainty in measurements
(7) S - Calculate percentage uncertainty
(8) C - Combine absolute and percentage uncertainty



Percentage uncertainty - A measure of accuracy

Key point

$$\text{percentage uncertainty} = \frac{\text{uncertainty (absolute)}}{\text{measured value}} \times 100\%$$

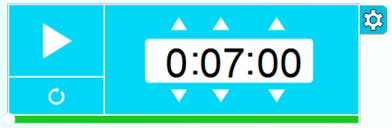
(give students one high volume one low volume)

Example measuring cylinder (from starter) -
Find the % uncertainty of the 2 values in the starter.
Comment on the answer....

16.5 ml. 1.5%

5 ml. 5%

(6) M - Identify uncertainty in measurements
(7) S - Calculate percentage uncertainty
(8) C - Combine absolute and percentage uncertainty



Combining uncertainty

Key point

In a calculation, if several of the quantities have uncertainties then these will all contribute to the uncertainty in the answer. The following rules will help you calculate the uncertainty in your final answers.

1. When quantities are added, the uncertainty is the sum of the ***absolute*** uncertainties.
2. When quantities are subtracted, the uncertainty is also the sum of the ***absolute* uncertainties.**

Example

John 186cm +- 0.1cm.
Alice 175cm +- 0.1cm

If Alice stands on Johns head, what is the combined height?

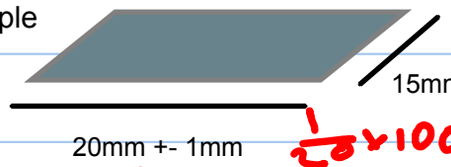
3. 361 ± 0.2

When quantities are multiplied, the *total percentage* uncertainty is the sum of the *percentage* uncertainties.

4. When quantities are divided, the *total percentage* uncertainty is also the sum of the *percentage* uncertainties.

Example

Find the area, including the absolute uncertainty

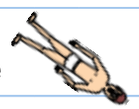


1/15 x 100 = 6.6%
1/20 x 100 = 5%
6.6 + 5 = 11.6

5. a = W x l = 15 x 20 = 300 ± 12%

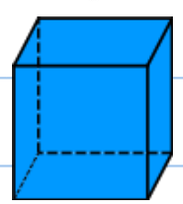
When a quantity is raised to the power *n*, the *total percentage* uncertainty is *n* multiplied by the *percentage* uncertainty – for example, for a quantity x^2, total percentage uncertainty = 2 × percentage uncertainty in *x*.

Example



Fred's pool is a perfect cube of length (L) = 8m +-0.05m

Find the volume of the cube and the uncertainty.



(6) M - Identify uncertainty in measurements
(7) S - Calculate percentage uncertainty
(8) C - Combine absolute and percentage uncertainty

Mini practical: Take measurements to find the density of copper/steel/ aluminum including the uncertainty.

Show full working out for each calculation.

Kilo 10^3

Mega 10^6

Giga 10^9

Ex: Ex: How do your reduce your percentage uncertainty?

Key point

density of copper = percentage uncertainty =

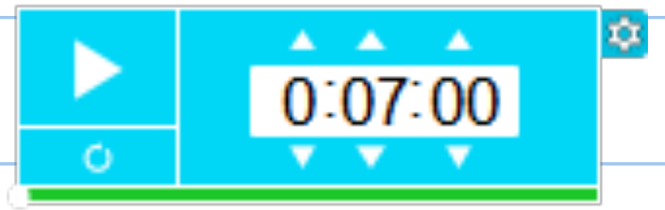
density of aluminum = percentage uncertainty =

density of steel = percentage uncertainty =

Aluminum	2712	kgm^{-3}
Steel	7850	
Copper	8940	

(6) M - Identify uncertainty in measurements
(7) S - Calculate percentage uncertainty
(8) C - Combine absolute and percentage uncertainty

Plenary



A flea is measured to be 1.2mm with a micrometer with resolution 0.1mm

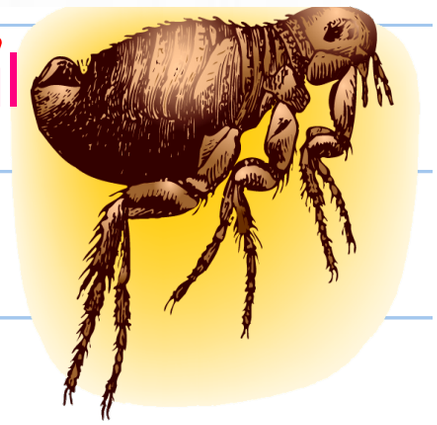
a) Write the measurement including the uncertainty.

1.2 mm ± 0.05 mm ✓

b) calculate the percentage uncertainty.

$\%U = \Delta U / v \times 100$ 4.16% ≈ 4.2%

Ex: Why is percentage uncertainty consider more useful



What are the limitations in this value of uncertainty?